REMARKS

A Petition for One-Month Extension of time is filed concurrently herewith.

Entry of this Amendment is proper because it narrows the issues on appeal and does not require further search by the Examiner.

Claims 1-26 are all the claims presently pending in the Application. Claims 11 and 13-26 have been withdrawn from consideration. Claim 1 has been amended to more particularly define the invention. Attached hereto is a marked-up version of the changes made to the claims by the current Amendment.

It is noted that the claim amendments are made only for more particularly pointing out the invention, and not for distinguishing the invention over the prior art, narrowing the claims or for any statutory requirements of patentability. Further, Applicant specifically states that no amendment to any claim herein should be construed as a disclaimer of any interest in or right to an equivalent of any element or feature of the amended claim.

Claims 1-2 stand rejected under 35 U.S.C. § 102(e) as being unpatentable over Onomura et al. (U.S. Patent No. 6,185,238 B1). Claims 1 and 12 stand rejected under 35 U.S.C. § 102(e) as being unpatentable over Nitta et al. (U.S. Patent No. 6,281,526 B1). Claims 3-6 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Onumura in view of Yanagihara et al. (U.S. Patent No. 5,523,623). Claims 7-10 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Onumura in view of Yanagihara, and further in view of Neumann et al. (U. S. Patent No. 5,614,736).

These rejections are respectfully traversed in view of the following discussion.

I. THE CLAIMED INVENTION

The claimed invention is directed to a flip chip type of light-emitting semiconductor device which includes a substrate, group III nitride compound semiconductor layers formed on the substrate, and a positive electrode including at least one layer of a first positive electrode layer which is formed on or above a p-type semiconductor layer and reflects light toward the substrate, the first positive electrode layer being made of at least one of silver (Ag), rhodium (Rh), ruthenium (Ru), platinum (Pt), palladium (Pd), and an alloy including at

least one of these metals.

Importantly, in the claimed invention, the substrate transmits the light reflected from the positive electrode, and light is emitted from a substrate side of the light-emitting device.

Conventional flip chip light-emitting semiconductor devices commonly direct light through the positive electrode layer. In other words, such devices are not used to direct light through the substrate which is on the opposite side of the emission layer from the positive electrode layer.

The claimed invention, on the other hand, includes a flip-chip light-emitting semiconductor device in which the substrate transmits the light reflected from the positive electrode, and light is emitted from a substrate side of the light-emitting device. Therefore, the claimed device can be used to direct light through the substrate.

II. THE PRIOR ART REFERENCES

A. The Onomura Reference

The Examiner alleges that Onomura teaches the claimed invention (e.g., as recited in claims 1 and 2). Applicant submits, however, that there are elements of the claimed invention which are neither taught nor suggested by Onomura.

Onomura discloses a nitride compound semiconductor laser including an active layer sandwiched by semiconductor layers of different conduction types on a sapphire substrate, layers of polyimide for current blocking and light confinement are formed on side surfaces of a mesa-type current confining structure with and under the p-side electrode (Onomura at Abstract).

However, Applicant submits that Onomura does not teach or suggest a flip chip type of light-emitting semiconductor device in which "*said substrate transmits said light reflected from said positive electrode, and light is emitted from a substrate side of said light-emitting device*" as recited in claim 1.

As noted above, unlike conventional flip chip light-emitting semiconductor devices which commonly direct light through the positive electrode layer, the claimed invention includes device in which the substrate transmits the light reflected from the positive

electrode, and light is emitted from a substrate side of the light-emitting device (Application at page 2, lines 18-25; Figure 1). Therefore, the claimed device can be used to transmit light through the substrate.

Specifically, the claimed device includes a positive electrode including at least one layer formed on or above a p-type semiconductor layer. The positive electrode includes a layer made of at least one of silver (Ag), rhodium (Rh), ruthenium (Ru), platinum (Pt), palladium (Pd), and an alloy including at least one of these metals, and reflects light toward the substrate (Application at page 14, lines 2-11). The novel features of the claimed invention allow it to have a low driving voltage and a positive electrode with good reflectivity, low corrosivity, and good adhesion (Application at page 7, line 3-page 8, line 26).

Clearly, Onomura does not teach or suggest these novel features. Indeed, Onomura does not even recognize at least one of the problems (e.g., poor luminous intensity) which the claimed invention is intended to address. Instead, Onomura is merely concerned with suppressing higher-order modes other a fundamental transverse mode.

The Examiner relies on Figure 5 in Onomura to support his allegations. However, Figure 5 shows a device having layers 508 formed on the sides of the active layer 505. The layers 508 guide the emitted light in a direction along the guide layer. In other words, light is not emitted in the direction of the electrode 509.

Indeed, Applicant notes that the electrode 509 in Onomura is formed only on a small portion of the p-type GaN layer 507. Therefore, it is clear that Onomura does not intend the electrode 509 to have the same function as the electrode of the claimed invention.

Therefore, it is clear that light in the Onomura device is not reflected by the positive electrode. Thus, nowhere does Onomura disclose or suggest that light reflected from the positive electrode is transmitted by the substrate, or that light is emitted from a substrate side of the light-emitting device. Therefore, the Onomura device is completely unrelated to the claimed device.

More specifically, on page 5 of the Office Action, the Examiner states that Onomura discloses a flip-chip type light-emitting semiconductor in col 6, lines 52-53.

However, Onomura's device is a laser comprising a current blocking layer structure

(i.e., a structure comprising a pair of insulating layers 111 shown in Onomura's FIG. 1). Thus, a cavity of the current blocking layer 111 is formed in a direction vertical to FIG. 1 showing a cross-sectional view of the wafer, and the laser is emitted in the same direction.

Further, because the active layer 105 has a separate confinement hetero-structure (SCH) in which guide layers are formed on the both sides of the active layer, light is essentially guided in a direction vertical to the sectional surface of the wafer along the guide layer. Accordingly, light is never emitted in the direction of an electrode 109, which proves that light is never reflected by the electrode 109 toward the substrate side. Thus, clearly, there is no teaching or suggestion by Onomura of a substrate which transmits "*light reflected from said positive electrode*" as recited in claim 1.

Onomura also discloses mounting the laser on a heat sink 520 face down (e.g., upside down), as shown in FIG. 7. Thus, the Onomura flip-chip device is attached face down (e.g., upside down) as described in Onomura's column 11, lines 46-49. Even when the laser is mounted on the heat sink as shown in FIG. 7, a cavity is formed in a direction vertical to the sectional surface of the device in FIG. 7, and light may not be emitted to the direction of the electrode 109. As described above, in this flip-chip type laser, light is not reflected by the electrode 109 and is never radiated from the substrate side 101.

On the contrary, in the present invention, light emitted by an emission layer is radiated in the direction of the emission layer thickness. Therefore, for example as shown in Figure 1, light radiated by the emission layer 104 is reflected by an electrode 120 in the direction of substrate 101, transmitted by the substrate 101, and radiated out of the device through the substrate 101. Accordingly, the present invention is completely different from Onomura's invention which discloses the electrode 109 which has no function of reflecting light.

Therefore, Applicant submits that there are elements of the claimed invention that are not taught or suggested by Onomura. Therefore, the Examiner is respectfully requested to withdraw this rejection.

B. The Nitta Reference

The Examiner alleges that Nitta teaches the claimed invention (e.g., as recited in

claims 1 and 12). Applicant submits, however, that there are elements of the claimed invention which are neither taught nor suggested by Nitta.

Nitta discloses an electrode of a metal (e.g., one of Group IV and VI elements) or an electrode material of carbon, germanium, selenium, rhodium, tellurium, iridium, zirconium, hafnium, copper, titanium nitride, tungsten nitride, molybdenum or titanium silicide, with an implanted impurity for increasing the carrier concentration of the semiconductor layer (Nitta at Abstract).

However, Applicant submits that Nitta does not teach or suggest a flip chip type of light-emitting semiconductor device in which "*said substrate transmits said light reflected from said positive electrode, and light is emitted from a substrate side of said light-emitting device*" as recited in claim 1.

As noted above, unlike conventional flip chip light-emitting semiconductor devices which commonly direct light through the positive electrode layer, the claimed invention includes device in which the substrate transmits the light reflected from the positive electrode, and light is emitted from a substrate side of the light-emitting device (Application at page 2, lines 18-25; Figure 1). The novel features of the claimed invention allow it to have a low driving voltage and a positive electrode with good reflectivity, low corrosivity, and good adhesion (Application at page 7, line 3-page 8, line 26).

Clearly, Nitta does not teach or suggest the limitations of claims 1 and 12. Indeed, Nitta does not even recognize at least one of the problems (e.g., poor luminous intensity) which the claimed invention is intended to address. Instead, Nitta is merely concerned with electrode contact resistance and bond strength.

The Examiner relies on Figure 5 in Nitta to support his allegations. However, Figure 5 shows a device like the device in Figure 1B, which is described stating "the light emitted from the active layer 20 is **designed to penetrate the electrode layer 26** to be extracted from the top surface" (Nitta at col. 6, lines 47-49) (emphasis Applicant's). In other words, in the device shown in Figure 5, the light is not reflected by the electrode layer 26'. Instead, the light penetrates the electrode layer 26' and is emitted through the top surface of the device.

Therefore, it is clear that light in the Nitta device is not reflected by the positive

electrode. Further, nowhere does Nitta disclose or suggest that light reflected from the positive electrode is transmitted by the substrate, or that light is emitted from a substrate side of the light-emitting device. Therefore, the Nitta device is completely unrelated to the claimed device.

Looking at the Examiner's comments, on page 5 of the Office Action, the Examiner states that Nitta discloses a flip-chip type light-emitting device in col. 4, line 43. This passage, however, only mentions that a flip-chip device packaging is difficult when a bond strength of an electrode is weak. The Examiner also states that Nitta teaches Rh as a positive electrode. However, Nitta only discloses a device in which light passes through a p-electrode 26 and is emitted from the upper surface of the device, as shown in col. 6, lines 46-49. Because light passes through the p-electrode 26 in Nitta's device, Nitta's teachings directly contradict the clear limitations of claims 1 and 12 of the present invention.

Unlike the Nitta device, in the present invention, a positive electrode, preferably with high reflectivity is used to reflect light to the substrate side. Then, the light transmits through the substrate, and is radiated to the outside from the substrate side of the device. Nitta clearly does not teach or suggest such a light-emitting device. Indeed, Nitta's so-called "flip chip packaging" (column 4, lines 41-42) is different from a "flip-chip device" which is used face down.

Therefore, Applicant submits that there are elements of the claimed invention that are not taught or suggested by Nitta. Therefore, the Examiner is respectfully requested to withdraw this rejection.

C. The Yanagihara Reference

Regarding the §103 rejection of claims 3-6, the Examiner alleges that Yanagihara would have been combined with Onomura to form the claimed invention (e.g., as claimed in claims 3-6). Applicant submits, however, that these references would not have been combined and even if combined, the combination would not teach or suggest each and every element of the claimed invention.

Yanagihara discloses an ohmic electrode for a p-type III-V compound semiconductor

device. The ohmic electrode formed on a p-type III-V compound semiconductor layer includes nickel (Ni), titanium (Ti), and platinum (Pt) as main components in an interface between the ohmic electrode and the p-type III-V compound semiconductor layer (Yanagihara at Abstract).

However, Applicant submits that these references would not have been combined as alleged by the Examiner. Indeed, these references are directed to different problems and provide completely different solutions to such problems. Specifically, the Onomura device is directed to suppressing higher-order modes other than a fundamental transverse mode, whereas Yanagihara is directed to reducing an electrode contact resistance. Therefore, a person of ordinary skill in the art would not have considered combining these references, absent impermissible hindsight.

Further, Applicant submits that the Examiner can point to no motivation or suggestion in the references to urge the combination as alleged by the Examiner. Indeed, the Examiner merely states that it would have been obvious to combine these references "for the purpose of providing a low contact resistance between the ohmic electrode and the p-type semiconductor layer" which is insufficient to support the combination.

Moreover, Applicant submits that Yanagihara does not teach or suggest a flip chip type of light-emitting semiconductor device in which "*said substrate transmits said light reflected from said positive electrode, and light is emitted from a substrate side of said light-emitting device*" as recited in claim 1. As mentioned above, the novel features of the claimed invention allow it to have a low driving voltage and a positive electrode with good reflectivity, low corrosivity, and good adhesion (Application at page 7, line 3-page 8, line 26).

Clearly, Yanagihara either alone or in combination with Onomura, does not teach or suggest these novel features. Indeed, Yanagihara does not even recognize at least one of the problems (e.g., poor luminous intensity) which the claimed invention is intended to address. Instead, Yanagihara is merely concerned with electrode contact resistance.

The Examiner relies on Figure 2 in Yanagihara to support his allegations. However, Figure 2 merely shows a device in which the p-type ohmic electrode 4 and the GaAs layer 2 are alloyed to each other in the diffusion layer 3 (Yanagihara at col. 5, lines 19-21). Indeed,

nowhere does Yanagihara either alone or in combination with Onomura, teach or suggest that the electrode 4 reflects light.

Therefore, it is clear that light in the Yanagihara device is not reflected by the positive electrode. Thus, nowhere does Yanagihara disclose or suggest that light reflected from the positive electrode is transmitted by the substrate, or that light is emitted from a substrate side of the light-emitting device. Therefore, the Yanagihara device is completely unrelated to the claimed device.

Further, Yanagihara discloses using Ni as a p-layer, but fails to disclose using Co for the p-layer. Further, Yanagihara fails to disclose a two-layer structure where a layer comprising Ag, Rh, Ru, Pt, or Pd is formed on the layer comprising Co or Ni (e.g., as recited in claim 3). In addition, because neither Yangihara nor Onomura teaches or suggests a reflective electrode, their inventions would not have been combined to form the claimed invention.

Therefore, Applicant submits that these references would not have been combined and even if combined, the combination would not teach or suggest each and every element of the claimed invention. Therefore, the Examiner is respectfully requested to withdraw this rejection.

D. The Neumann Reference

Regarding the §103 rejection of claims 7-10, the Examiner alleges that Neumann would have been combined with Onomura and Yanagihara to form the claimed invention. Applicant submits, however, that these references would not have been combined and even if combined, the combination would not teach or suggest each and every element of the claimed invention.

Neumann discloses a green light emitting diode which includes a doped semiconductor substrate wafer. A zinc-doped contact is applied to the p-conductive side of the wafer for generation of pure green light emissions. An electrically conductive layer is provided between the zinc-doped contact layer and the p-conductive wafer side to suppress diffusion of oxygen into the p-conductive wafer side during diode manufacture (Neumann at

Abstract).

However, Applicant submits that these references would not have been combined as alleged by the Examiner. Indeed, these references are directed to different problems. Specifically, as noted above, the Onomura device is directed to suppressing higher-order modes other a fundamental transverse mode, and Yanagihara is directed to reducing an electrode contact resistance, whereas Neumann is directed to efficient green light emission. Therefore, no person of ordinary skill in the art would have considered combining these references.

Further, Applicant submits that the Examiner can point to no motivation or suggestion in the references to urge the combination as alleged by the Examiner. Indeed, the Examiner merely states that it would have been obvious to combine these references "for the purpose of providing a highly desirable, good ohmic contact as taught by Neumann" which is insufficient to support the combination.

Moreover, Applicant submits that Neumann does not teach or suggest a flip chip type of light-emitting semiconductor device in which "*said substrate transmits said light reflected from said positive electrode, and light is emitted from a substrate side of said light-emitting device*" as recited in claim 1. The novel features of the claimed invention allow it to have a low driving voltage and a positive electrode with good reflectivity, low corrosivity, and good adhesion (Application at page 7, line 3-page 8, line 26).

Clearly, Neumann does not teach or suggest the limitations in the claimed combination. Indeed, Neumann does not even recognize at least one of the problems (e.g., poor luminous intensity) which the claimed invention is intended to address. Instead, Neumann is merely concerned with improving a green light emission efficiency.

The Examiner relies on Figure 1 in Neumann to support his allegations. However, Figure 1 merely shows a device which includes a p-type layer 3, an electrically conductive layer 4, a zinc/gold layer 5, a diffusion blocking layer 6, and a metal layer 7 (Neumann at col. 3, lines 13-43). However, nowhere does Neumann teach or suggest that any of these layers (including conductive layer 4) reflects light from an emission layer.

Thus, nowhere does Neumann disclose that light reflected from a positive electrode is

transmitted by the substrate, or that light is emitted from a substrate side of the light-emitting device. Therefore, the Neumann device is completely unrelated to the claimed device.

Further, Neumann may disclose an Au electrode, but Neumann fails to teach or suggest a three-layer structure in which a Au layer is formed between a layer comprising Co or Ni and a layer comprising Ag, Rh, Ru, Pt, or Pd (e.g., as recited in claim 7). In addition, neither Neumann nor Onomura teaches or suggests a reflective electrode, so the references would not have been combined to form the claimed invention.

Therefore, Applicant submits that these references would not have been combined and even if combined, the combination would not teach or suggest each and every element of the claimed invention. Therefore, the Examiner is respectfully requested to withdraw this rejection.

IV. FORMAL MATTERS AND CONCLUSION

In view of the foregoing, Applicant submits that claims 1-10 and 12, all the claims presently pending in the application, are patentably distinct over the prior art of record and are in condition for allowance. The Examiner is respectfully requested to pass the above application to issue at the earliest possible time.

Should the Examiner find the application to be other than in condition for allowance, the Examiner is requested to contact the undersigned at the local telephone number listed below to discuss any other changes deemed necessary in a telephonic or personal interview.

The Commissioner is hereby authorized to charge any deficiency in fees or to credit any overpayment in fees to Attorney's Deposit Account No. 50-0481.

Respectfully Submitted,

Date: 1/30/03

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VERSION WITH MARKINGS TO SHOW CHANGES MADE

IN THE CLAIMS:

Please amend the claims to read as follows:

1. (Amended) A flip chip type of light-emitting semiconductor device comprising:

a substrate;

group III nitride compound semiconductor layers formed on said substrate, said layers comprising a p-type semiconductor layer; and

a positive electrode including at least one layer of a first positive electrode layer which is formed on or above said a p-type semiconductor layer and reflects light toward said substrate, said first positive electrode layer being made of at least one of silver (Ag), rhodium (Rh), ruthenium (Ru), platinum (Pt), palladium (Pd), and an alloy including at least one of these metals,

wherein said substrate transmits said light reflected from said positive electrode, and light is emitted from a substrate side of said light-emitting device.